WHAT IS CLAIMED IS:

1. A crystallization apparatus comprising an illumination system which illuminates a phase shifter having at least one phase shift portion, and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution in which a light intensity is minimum in a point area corresponding to the phase shift portion of the phase shifter, thereby forming a crystallized semiconductor film,

wherein the phase shifter has four or more even-numbered phase shift lines which intersect at a point constituting the phase shift portion, and an area on one side and an area on the other side of each phase shift line have a phase difference of approximately 180 degrees.

2. The crystallization apparatus according to claim 1, wherein the phase shifter has a conformation that four rectangular areas including said areas are arranged so as to be adjacent to each other with one apex in common.

3. The crystallization apparatus according to claim 1, wherein the phase shifter has a conformation that six or more triangular areas including said areas are arranged so as to be adjacent to each other with one apex in common.

4. The crystallization apparatus according to

claim 1, wherein the phase shifter has a first phase shift portion at which even-numbered first phase shift lines intersect and a second phase shift portion at which even-numbered second phase shift lines intersect, and a plurality of first phase shift portions and a plurality of second phase shift portions are alternately arranged.

5. The crystallization apparatus according to claim 4, wherein the first phase shift portion corresponds to a point at which the four phase shift lines intersect, and the second phase shift portion corresponds to a point at which the eight phase shift lines intersect.

6. The crystallization apparatus according to claim 5, wherein the first phase shift portion corresponds to one apex provided to the four triangular areas including said areas in common, and the second phase shift portion corresponds to one apex provided to the eight triangular areas in common.

7. The crystallization apparatus according to claim 1, wherein the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter are arranged in parallel with and in close proximity to each other.

8. The crystallization apparatus according to claim 1, wherein the illumination system has an outgoing radiation pupil having a shape that

a dimension along one direction and a dimension along the other direction are substantially different from each other.

9. The crystallization apparatus according to claim 8, wherein assuming that D is a distance between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, λ is a wavelength of the light, θmax is a maximum incident angle of the light upon the phase shifter along a direction in which an outgoing radiation pupil of the illumination system is maximum, and θmin is a maximum incident angle of the light upon the phase shifter along a direction in which the outgoing radiation pupil of the illumination system is minimum, the following conditions are satisfied:

$$D \times \tan(\theta min) < 1.2 \times (\lambda D/2)^{1/2}$$

$$D \times \tan(\theta max) > 1.2 \times (\lambda D/2)^{1/2}$$

10. The crystallization apparatus according to claim 1 further comprising an image forming optical system arranged on an optical axis between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, and

wherein the polycrystal semiconductor film or the amorphous semiconductor film is set apart from a surface optical conjugate with the phase shifter by a predetermined distance along an optical axis of the image forming optical system.

11. The crystallization apparatus according to claim 1 further comprising an image forming optical system arranged on a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, and

wherein the polycrystal semiconductor film or the amorphous semiconductor film is set to a surface which is optically substantially conjugate with the phase shifter, and

an image side numerical aperture of the image forming optical system is set to a value used to generate the light intensity distribution.

12. The crystallization apparatus according to claim 11, wherein the image forming optical system has a pupil having a shape that a dimension along one direction and a dimension along the other direction are substantially different from each other.

13. A crystallization apparatus which forms a crystallized semiconductor film by irradiating a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution,

wherein the predetermined light intensity distribution has an inverse peak point with a light intensity lower than that at the periphery and has two or more trough lines which extend from the inverse peak point toward the periphery and have a lower change

gradient of a light intensity than that at the periphery.

14. The crystallization apparatus according to claim 13, wherein the light intensity distribution along each of the trough lines has an inflection point.

15. A crystallization apparatus which comprises an illumination system which illuminates a polycrystal semiconductor film or an amorphous semiconductor film through a phase shifter having a phase shift portion, the phase shifter modulating an incident light beam into a light beam having a predetermined light intensity distribution that a light intensity is minimum in an area corresponding to the phase shift portion, a crystallized semiconductor film being formed from the polycrystal semiconductor film or the amorphous semiconductor film by using the modulated light beam,

wherein the phase shifter has at least four areas, these areas define phase shift lines between the adjacent areas having different phases, and the phase shift lines interest at one end, thereby constituting a point-like phase shift portion.

16. The crystallization apparatus according to claim 15, wherein the at least four areas are divided into two groups whose phases are shifted by 180 degrees.

17. A crystallization method which illuminates

a phase shifter, and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution that a light intensity is minimum in an area corresponding to a phase shift portion of the phase shifter, thereby generating a crystallized semiconductor film,

wherein the method uses the phase shifter which has four or more even-numbered phase shift lines which interest at a point constituting the phase shift portion, an area on one side and an area on the other side of each phase shift line having a phase difference of approximately 180 degrees.

18. The crystallization method according to claim 17, wherein the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter are arranged in parallel with and in close proximity to each other.

19. The crystallization method according to claim 17, wherein an image forming optical system is arranged on a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, and

a surface of the polycrystal semiconductor film or the amorphous semiconductor film being set apart from a plane optically conjugate with the phase shifter by a predetermined distance along an optical axis of the

image forming optical system.

20. The crystallization method according to claim 17, wherein an image forming optical system is arranged on a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter,

an image side numeral aperture of the image forming optical system is set to a value used to generate the predetermined light intensity distribution, and

the polycrystal semiconductor film or the amorphous semiconductor film is set to a position optical conjugate with the phase shifter through the image forming optical system.

21. A crystallization method which generates a crystallized semiconductor film by irradiating a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution,

wherein the polycrystal semiconductor film or the amorphous semiconductor film is irradiated with a light beam having a light intensity distribution which has an inverse peak pattern with a lower light intensity than that at the periphery, and has two or more trough lines each of which extends from the inverse peak point toward the periphery and has a lower change gradient of the light intensity than that at the periphery.

22. A phase shifter which has four or more even-numbered phase shift lines which interest at a point constituting a phase shift portion, wherein respective two adjacent areas with different phases which define each phase shift line therebetween have a phase difference of approximately 180 degrees.

23. The phase shifter according to claim 22, wherein four rectangular areas including said areas have a conformation that they are arranged so as to be adjacent to each other with one apex in common.

24. The phase shifter according to claim 22, wherein six or more triangular areas including said areas are arranged so as to be adjacent to each other with one apex in common.

25. The phase shifter according to claim 22, further comprising a first phase shift portion at which even-numbered first phase shift lines intersect and a second phase shift portion at which even-numbered second phase shift lines intersect, wherein a plurality of first phase shift portions and a plurality of second phase shift portions are alternately arranged.

26. The phase shifter according to claim 25, wherein the first phase shift portion corresponds to a point at which the four phase shift lines interest, and the second phase shift portion corresponds to a point at which the eight phase shift lines intersect.

27. The phase shifter according to claim 26,

wherein the first phase shift portion corresponds to one apex provided to four triangular areas in common, and the second phase shift portion corresponds to one apex provided to eight triangular areas in common.

28. A crystallization apparatus which comprises an illumination system which illuminates a phase shifter, and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film,

wherein the phase shifter has a first phase shift line which linearly extends along a predetermined direction and a second phase shift line which is continuous with the first phase shift line and meanders along the predetermined direction.

29. A crystallization apparatus which comprises an illumination system which illuminates a phase shifter, and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film,

wherein the phase shifter has a first phase shift line which meanders with a first shaped width along a predetermined direction and a second phase shift line which is continuous with the first phase shift line and

meanders with a second shaped width substantially larger than the first shaped width along the predetermined width.

30. The crystallization apparatus according to claim 28, wherein areas defining with the first phase shift line and the second phase shift line therebetween have a phase difference of approximately 180 degrees.

31. A crystallization apparatus which comprises an illumination system which illuminates a phase shifter, and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film,

wherein the phase shifter has a first phase shift line which linearly extends along a predetermined direction, a second phase shift line which meanders along the predetermined direction and a third phase shift line which linearly extends and crosses the first phase shift line.

32. The crystallization apparatus according to claim 31, wherein an area on one side and an area on the other side of the first phase shift line and the second phase shift line have a phase difference of approximately 180 degrees, and an area on one side and an area on the other side of the third phase shift line have a phase difference of approximately 180 degrees.

33. The crystallization apparatus according to claim 31, wherein the first phase shift line and the third phase shift line are substantially orthogonal to each other.

34. The crystallization apparatus according to claim 28, wherein the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter are arranged in substantially parallel with and in close proximity to each other.

35. The crystallization apparatus according to claim 34, wherein assuming that λ is a wavelength of the light and D is a distance between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, the shaped width W of the second phase shift line satisfies the following condition:

$$W > 0.6 \times (\lambda D/2)^{1/2}$$

36. The crystallization apparatus according to claim 28 further comprising an image forming optical system which is arranged in a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter,

wherein the polycrystal semiconductor film or the amorphous semiconductor film is set apart from a surface optical conjugate with the phase shifter by a predetermined distance along an optical axis of the image forming optical system.

37. The crystallization apparatus according to

claim 28 further comprising an image forming optical system which is arranged in a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter,

wherein the polycrystal semiconductor film or the amorphous semiconductor film is set to a surface optically substantially conjugate with the phase shifter, and

an image side numerical aperture of the image forming optical system is set to a necessary value used to generate the predetermined light intensity distribution.

38. The crystallization apparatus according to claim 37, wherein assuming that λ is a wavelength of the light and NA is an image side numerical aperture of the image forming optical system, the shaped width W of the second phase shift line satisfies the following condition:

$W > 0.305 \times \lambda/NA$

39. A crystallization method which illuminates a phase shifter and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film,

the method using a phase shifter having a first phase shift line which linearly extends along

a predetermined direction and a second phase shift line which is continuous with the first phase shift line and meanders along the predetermined direction.

40. A crystallization method which illuminates a phase shifter and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film

the method using a phase shifter having a first phase shift line which meanders with a first shaped width along a predetermined direction and a second phase shift line which is continuous with the first phase shift line and meanders with a second shaped width substantially larger than the first shaped width along the predetermined direction.

41. A crystallization method which illuminates a phase shifter and irradiates a polycrystal semiconductor film or an amorphous semiconductor film with a light beam having a predetermined light intensity distribution through the phase shifter, thereby generating a crystallized semiconductor film,

the method using a phase shifter having a first phase shift line which linearly extends along a predetermined direction, a second phase shift line which is continuous with the first phase shift line and meanders along the predetermined direction, and a third

phase shift line which linearly extends and crosses the first phase shift line.

42. The crystallization method according to claim 39, wherein the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter are arranged in substantially parallel with and in close proximity to each other.

43. The crystallization method according to claim 39, wherein an image forming optical system is arranged in a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter, and

a surface of the polycrystal semiconductor film or the amorphous semiconductor film is set apart from a surface optically conjugate with the phase shifter by a predetermined distance along an optical axis of the image forming optical system.

44. The crystallization method according to claim 39, wherein an image forming optical system is arranged in a light path between the polycrystal semiconductor film or the amorphous semiconductor film and the phase shifter,

an image side numerical aperture of the image forming optical system is set to a necessary value used to generate the predetermined light intensity distribution, and

the polycrystal semiconductor film or the

amorphous semiconductor film is set at a position optically conjugate with the phase shifter through the image forming optical system.

45. A crystallization method, wherein a phase shifter having a first phase shift line which extends along one direction and a second phase shift line which is continuous with the first phase shift line, extends in the one direction and meanders is used to modulate an incident light beam into a light beam having a light intensity distribution with an inverse peak pattern, a semiconductor film is irradiated with the modulated light, a crystal growth start point is formed at a position corresponding to the first phase shift line, and a crystal is grown along the second phase shift line from the crystal growth start point.

46. A phase shifter having a first phase shift line which linearly extends along a predetermined direction and a second phase shift line which is continuous with the first phase shift line and meanders along the predetermined direction.

47. A phase shifter having a first phase shift line which meanders with a first shaped width along a predetermined direction and a second phase shift line which meanders with a second shaped width substantially larger than the first shaped width along the predetermined direction.

48. The phase shifter according to claim 46 having

a plurality of areas which define the first phase shift line and the second phase shift line therebetween, wherein the adjacent areas have a phase difference of approximately 180 degrees.

49. A phase shifter having a first phase shift line which linearly extends along a predetermined direction, a second phase shift line which is continuous with the first phase shift line and meanders along the predetermined direction, and a third phase shift line which linearly extends and crosses the first phase shift line.

50. The phase shifter according to claim 49, wherein an area on one side and an area on the other side of the first phase shift line and the second phase shift line have a phase difference of approximately 180 degrees, and an area on one side and an area on the other side of the third phase shift line have a phase difference of approximately 180 degrees.

51. The phase shifter according to claim 49, wherein the first phase shift line and the third phase shift line are substantially orthogonal to each other.